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405 Beam Business Administration Building
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(814) 863-2382

The Cadillac Quality Story

Ally Hamood
General Motors

The Cadillac Motor Car Division of General Motors was a 1990 winner of the Malcolm Baldrige National Quality Award. This award capped a six year effort to reestablish Cadillac as the premier American luxury automobile. By 1985, Cadillac had slipped to 16th on the J. D. Powers' Customer Satisfaction Index. By 1990, it had recovered to 4th. Cadillac had improved 27% on GM's own customer satisfaction index, which is based on a customer's three month total ownership experience. Problems experienced by customers dropped by 67% and warranty costs dropped by 29% even though total warranty coverage has been extended. Cadillac received the highest score among GM domestic cars four years in a row. On the J. D. Powers' Customer Handling Index, Cadillac's Coupe DeVilles and Sedan DeVilles scored first place, while Cadillac overall scored second place. Its repurchase loyalty improved 24% in three years, giving it the highest score of any car in the world. It has retained its world-wide market share, even though the number of entries into the luxury car market has increased substantially. Cadillac achieved its success by following three main strategies: a change in culture, a constant focus on the customer, and a disciplined approach to planning. Details on these three strategies are discussed below.

Cadillac's first main strategy, a change in culture, involved many initiatives. Since 1985, Simultaneous Engineering teams at various corporate levels have broken down the barriers between internal functions and include suppliers, dealers and UAW members. Approximately 700 employees now serve on these committees and about 75% of them include suppliers (increasingly single source). The Targets for Excellence program communicates expectations to suppliers concerning leadership, cost, quality, technology, and delivery. These standards mirror Baldridge criteria and are higher than European ISO 9000 standards. Suppliers on GM teams can assess improvement in their products on these criteria. Cadillac holds periodic Partners for Excellence conferences during which suppliers can provide input into GM's future planning.

Cadillac dealers are also asked to provide input into future planning through participation on Simultaneous Engineering teams as well as through corporate initiated "Listening Posts." In the latter, dealers provide electronic input to the corporate office on the product's performance in the marketplace.

The UAW-GM Quality Network, which was established in 1987, is made up of joint union-management Quality Councils at the corporate, division, and plant levels. Their beliefs and values focus around customer satisfaction. The Quality Network oversees all quality initiatives, including the implementation of 37 action strategies, including quality function deployment (QFD), error proofing, design of experiments, single minute exchange of dies (SMED), etc. Plants hold periodic "corporate analysis meetings" during which entire plants are shut down briefly for thorough quality audits. Six hundred plant level work teams with 5,000 workers focus on ways to "insource" business to a plant. Ally discussed a team that was able to eliminate $52 million from a bid, resulting in an increase of 154 jobs for the plant. He also discussed a team that oversaw the reduction in die exchange from twelve hours in 1987 to four minutes, fifty-nine seconds in 1989, and more recently to three minutes, forty-six seconds.

A final element of cultural change is Cadillac's People Strategy. The Cadillac Business Plan drives the People Strategy. The People Strategy includes ways to select and train employees, allow participation in decision-making, and provide for recognition and rewards that are consistent with achievement of the business plan. The People Strategy is carried out by the Human Resource Management Operating Committee which oversees seven People Strategy Teams, which, in turn, are responsible for the research, design, recommendation and implementation of Cadillac's people processes. Sixty percent of GM's employees are volunteer members of teams that concern people issues.

Cadillac's second major strategy concerns Customer Focus. The number of levels between dealers and company representatives has been reduced from seven to two by increased use of video-conferencing. As a result, there has been a 19% reduction in the "comeback rate" on unresolved customer problems. The dealer now has greater discretion in resolving warranty complaints. Also, Cadillac was the first to make its warranty coverage zero deductible.

Dealers were asked to comment on the 1988 Eldorado. Many criticized its design and offered suggestions for improvement. The suggestions were incorporated into a modified design within 55 weeks and led to a 43% improvement in sales over the previous year.

Cadillac has 21 toll-free numbers for use by its external customers. Representatives from plant teams also call customers to ask about complaints and then take these complaints to the teams for resolution. Cadillac's dedicated road service is now in its fourth year. Its customer surveys indicate that a major reason for repurchase of a Cadillac is related to the quality of this service.

Vehicle Clinics are held periodically to survey customers for ideas to incorporate into new products. Eight thousand customers viewed and were asked to comment on the prototypes for the 1992 Eldorado and Seville. Customer Councils meet regularly to discuss future products with engineers.

Simultaneous Engineering teams at plants focus on internal customers. The "voice of the assembler" is heard through the Assembly Line Effectiveness Center (A.L.E.C.) at Hamtramck, Michigan where future products are assessed for manufacturability. The center is staffed by both plant employees and Simultaneous Engineering team members.

Cadillac's Market Assurance Process integrates the voice of the customer. This process includes collection of data on customers and translates them via QFD into manufacturing specifications.

Cadillac's third main strategy concerns a disciplined approach to planning. Top management sets overall priorities, but employees through a variety of committees develop goals and action plans to meet them. The Vice President for Design (who heads the Advanced Engineering Staff) oversees the Program Product Management Process or Four Phase, which has been instrumental for new product development. During Phase Zero, the voices of customers, dealers, manufacturing, etc. are heard. This phase is completed long before the first prototype is developed. Also initiated was an analysis of process flow to determine what can been done in parallel versus simultaneously and to eliminate non-valued-added steps. This process shaved a full year off product development time. Also, assembly hours per car have been reduced by 58% since 1986. The Customer Oriented Vehicle Evaluation audit, which is based on fit, finish, appearance and performance, has improved 46% for Cadillac overall and 60% for Eldorado and Seville.

The Total Quality Initiative at Commercial Nuclear Fuel Division

Michele DeWitt
Westinghouse

Michele is Manager of Total Quality for the Commercial Nuclear Fuel Division (CNFD) of Westinghouse. CNFD was a 1988 winner of the Baldrige National Quality Award. The division began to focus in 1978 on developing quality as a core competence and as a basis for differentiation from its competitors.

CNFD is the world's leading producer of nuclear fuel for pressurized water reactors. General Electric leads in boiling water reactors, which is the other main reactor type. CNFD supplies eight percent of all nuclear fuel in the U.S. The fuel consists of uranium dioxide pellets. A fuel assembly is made up of approximately 300 zirconium tubes (each tube is .34 in diameter). There are approximately 150 to 200 fuel assemblies in a reactor. The main quality objective is to prevent contamination within the factory. Their current reliability is 99.9995%, but their goal is zero defects.

The CNFD is highly integrated and includes four locations: Ogden, Utah; Columbia, South Carolina; Monroeville and Blairsville, Pennsylvania. Zirconium is mined in Australia and Ogden, the tubes are produced in Blairsville, and are assembled in Columbia. Product design and general administration are located in Monroeville. Their vertical integration facilitates quality control and helps them to be very responsive to customer requests for new products and changes in products.

Sales are now made primarily to existing nuclear plants since demand has been virtually flat since the early 1980s. Thus, the primary competitive focus has shifted to productivity and cost. Total quality was seen as the basis for achieving these goals by producing the highest quality nuclear fuel. All of Westinghouse's competitors in fuel for pressurized water reactors have formed alliances with foreign companies in order to survive.

In 1985, CNFD developed a quality mission statement. Its quality strategy is built on four imperatives: management leadership, product/process leadership, human resource excellence, and customer orientation. Each of these four imperatives can be broken, in turn, into 12 conditions of excellence. The Westinghouse Productivity and Quality Center provided consulting, group facilitation, training, etc. The Science and Technology Center provided assistance in materials research and advanced manufacturing technology.

Management leadership has guided the quality initiative over the last 10 years. CNFD developed its first quality plan in 1983 and shared it with its customers. It developed quality circles in 1984, and division quality measures in 1985 and 1986. In 1988, it applied for the Baldrige Award and won. The award examination process taught them a lot about their weaknesses and strengths. Since 1989, CNFD has been sharing information with thousands of visitors to its sites. It has expanded its dimensions of total quality to include new measures, such as value to cost and value to price ratios. It has broadened participation by including personnel at all division levels and setting goals for the division, plants, and groups. Over 300 teams look at quality issues as well as new product development, etc. It looks regularly at trends in measures taken at eight "pulse points" (related to fuel reliability, total quality costs, "once through" measures, etc.) These eight vital measures

are reviewed monthly by all CNFD sites via computer conferencing. They are displayed on boards and discussed frequently at all levels of the organization. Their customers and shareholders also see these numbers.

CNFD has demonstrated product/process leadership also. Technologies such as SPC, JIT, SMED, and artificial intelligence have been implemented. Virtually every employee has received some type of quality training. The implementation of these technological and training programs have resulted in cycle time reduction of 40%. Long-term contracts have been established with fewer suppliers. The remaining ones have been certified so that incoming inspection is no longer necessary.

CNFD holds "key Issues forums" once a year. Two hundred managers discuss quality issues and see the quality, financial and strategic plan. Leadership potential is developed internally through Leadership 2000 training courses. All managers and two-thirds of professionals have been through this training, which includes leadership, ethics and change management. It is beginning to recycle the first wave of managers though refresher courses.

Customers also are integrated into company planning through a variety of groups and forums. These include Fuel Users Groups (meet twice a year), joint fuel examinations, and Customer Satisfaction Benchmark Meetings. Customer satisfaction is surveyed frequently and fed back to internal units.

The nuclear fuel business has been progressing over the last 20 years towards customized designs. Through customer involvement and changes in the development process, the cycle time for new fuel designs has been reduced from seven to two years.

Customer satisfaction, one of the eight pulse points has been steadily improving from "good" to "very good." Other pulse points that relate to first-time yields and error rates for first-time delivery of error-free software have improved dramatically in the last four to seven years. Orders for nuclear fuel continue to increase. Some of these long-term contracts contain provisions for sharing performance gains between CNFD and its customers. The 1991, CNFD was awarded the George Westinghouse Total Quality Award for the best division in Westinghouse.

Involving Customers and Suppliers in a Multifunctional Product Development Team

Jim Stryker
Ingersoll-Rand

Ingersoll-Rand had $3.7 billion in sales last year and ranked 132nd on the Fortune 500. It has seven operating divisions, 81 plants world-wide and 34,000 employees. Jim is the Product Development Manager for the Professional Tools Division, which makes hand-held pneumatic tools, such as drills, impact tools, and nut setters. Jim's story concerns the development of a pneumatic die grinder, which is traditionally viewed as a commodity product. Incremental improvements had been made to it three times in the 1980s. This time the Division General Manager wanted a substantially modified product that could be differentiated from the competition. Although the customary product development cycle was three to four years, he wanted this product to be developed in one year. He asked Jim to head the project, which was dubbed "Project Lightning." The goals set for the project required

a revolution in the product as well as in development time. The product development effort achieved both goals and led to doubling current market share from 20% to 40%. Jim's success story emphasizes the soft side of product development, i.e., the people dimension.

The product development team was formed at the Athens, Pennsylvania plant. While the hundred year old plant recently had a $25 million renovation, it had not had experience in developing a new product in 10 years. The full-time "core" team members were marketing, sales, engineering, manufacturing, and purchasing. There was a shop floor support team that was trained in Design For Assembly (DFA) techniques. There also were support teams consisting of vendors, customers and distributors.

The Division General Manager invited everyone to division headquarters in Liberty Corner, New Jersey. He asked everyone to commit publicly to the project's goals. Everyone did, but the extent to which this process led to internalized commitment was questionable. Jim thought that a milestone chart with colors for each function, etc. might help. Everyone was given a copy. It served as a crutch, but it didn't necessarily lead to internalized commitment.

Jim believes that internalized commitment comes from team members sharing a common vision. A common vision is needed for revolutionary products. Customers in this market are not the major source of insight for product revolution. They have ideas, but most ideas are non-proprietary and have been conveyed already to Ingersoll-Rand's competitors. Who is the customer is not always clear either. For example, the line foreman might form a judgment about the product by taking it to the largest worker in the factory to see if he can make it stall during use. If it doesn't stall, then it must have adequate torque and be OK. Their distributors generally said "make the best product, but reduce the cost by 5%." They also looked at their competitor's products for ideas to determine what they might do better. These sources of ideas can be as much barriers as sources for revolutionary product ideas.

The team hired an industrial design company to make recommendations about product design. In effect, this was design from the outside in. The team's acceptance of product design recommendations put pressure on design and engineering to move quickly before their options for internal design were limited. They had been reluctant to commit to the project's time frame initially.

When the core team met with customers, the issue of product "specs" arose. Specs also can be barriers as well as sources of ideas. Are specs movable, frozen, how far to leap?

A more effective approach is to have the team set its own specs based on their assessment of customer needs. An example is that the team knew that customers wanted a product with a durable cover. Engineering wanted specs, but the team couldn't come up with numbers. Instead, they drove around the plant's parking lot with aluminum covers from competitors' products and a proposed composite cover for their product; each was tied to team members' car bumpers. It was quite apparent after a few hours that the composite cover fared much better than the aluminum cover.

Jim believes that team members must set as many goals as possible, while management's role is to eliminate barriers. Senior management should stay out of the process except for milestone

reviews and for changing the project's scope. They need to give resources to the team and then trust them to do the job.

Goal difficulty is a double-edged sword. Goals need to be set for more than incremental improvement if team members are to identify new ways to do things. On the other hand, too much pressure can lead to burn-out and a desire to want to get the project over quickly. Frustration and conflict leads to the type of pressure that creates burn-out.

Jim discussed the "hidden" or "back-up" option that may need to be exercised if an existing goal seems unreachable. Such an option relies on ambiguity in the meaning of the project's goals. In this project, for example, achievement of the one-year goal could mean that 50,000 units of the product were on customers shelves within that time frame, or it could mean that a working prototype had been tested successfully. This ambiguity offers some slack in meeting the goal, if such slack becomes necessary.

Jim discussed the issue of who should be on the team. Not all the "best" people can be on the team, even if the "best" people were available for the project. Jim thinks that a balance is necessary between people who have a revolutionary perspective and those who have an evolutionary perspective. A balance is needed between visionaries and detail people.

Five people worked full-time as core team members, but they were supported by support teams from the shop floor, the CAD and model shop, and from distributors. Sales and marketing were very active as core team members during the concept definition stage (which took about four months), but did have some difficulty later in the project determining what their role should be. After they were asked to outline what they might do, their role became clearer.

Teams met periodically, but regular staff meetings are not essential for team development. Co-location is more important. Management involvement can be a crutch and a stimulator. Beyond milestone reviews, the team should ask for management's blessing on its ideas rather than for ideas from management about what to do. The team should have control over its own budget.

How Japanese Companies Maximize Learning Within and Between Product Development Cycles

Jeff Funk
Penn State

Jeff described how a Japanese semiconductor equipment business implements four key product development strategies: multifunctional problem-solving, close relations with suppliers and customers, incremental improvement, and learning. Multifunctional problem-solving is needed since product development requires the integration of different functions such as engineering, manufacturing and marketing. The semiconductor equipment business has institutionalized this type of problem-solving primarily by organizing itself by equipment group, where each equipment group is responsible for most of its own engineering, sales, marketing and purchasing. These equipment groups sit together in an open office and hold "daily standup" and weekly meetings. The open office facilitates informal communication. Key issues are summarized every day in a ten-to-fifteen minute standup meeting

that occurs immediately following lunch. More detailed discussions occur in the weekly meetings and one person from manufacturing acts as a liaison between manufacturing and an equipment group by attending the latter's weekly equipment meeting.

Customers and suppliers also participate in these multifunctional problem-solving activities. Multifunctional engineers perform most of the marketing, sales and purchasing functions by interacting directly with the business' customers and suppliers, most of whom are members of the firm's "keiretsu." Regular meetings are held with representatives from customers and suppliers, and representatives from the suppliers are often temporarily transferred to the business where they sit in the same part of the office with the relevant equipment group and attend its daily standup meeting.

Incremental improvement is the third key product development strategy used by this semiconductor equipment business. Detailed three and five year technology plans, project schedules and individual schedules enable the business to improve its existing equipment incrementally and develop and implement radical new equipment technologies incrementally at the same time. The semiconductor equipment business works closely with its customers on the development of these detailed technology plans and project schedules. These plans and schedules are the focus of many of the regular meetings held between the equipment business and its customers. The customers require and often fund many of the new technologies included in these plans.

Learning to get better and better at product development is the semiconductor equipment's fourth product development strategy. The business continually tries to reduce development time, improve equipment quality and increase the reuse of software. The existing process is the result of five years of learning and includes more than 200 individual steps that make an explicit connection between equipment specifications and software code. An engineer in an equipment group can perform any step in this process even if he or she has not performed the previous step. A number of working groups are also responsible for making further improvements to this process in a manner that is similar to the way Japanese factories make improvements. This methodology includes continual simplifications to the existing process, followed by simple automation and computer-integrated information systems.

Managing the Introduction and Effective Use of Quality Function Deployment

Larry Shillito
Eastman Kodak

Larry defined Quality Function Deployment (QFD) as a team process for designing product, process or service based on customer needs/requirements and involving all segments of the organization. QFD works best for redesigning an existing product rather than for conceptualizing a new product. It begins with the guiding principles that value is determined ultimately by the user, that there is no direct relationship between manufacturing cost and selling price, and that more growth will come from studying and responding to customer needs than from scientific breakthroughs.

The QFD process is based on four two-dimensional matrices. The first matrix links customer requirements (or voice of the customer) with design requirements. The second matrix links design

requirements with product/part characteristics. The third matrix links product/part characteristics with manufacturing operations, and, finally, the fourth matrix links manufacturing operations with operations/controls. If the linkages within and between matrices are maintained, the voice of the customer will be retained even at the most operational level.

The first matrix is called the House of Quality, because it resembles a house in appearance. Larry used a common candle to demonstrate how to fill in this matrix. First, the team would generate a list of customer attributes, e.g., fragrance, smokeless, dripless, etc., which are then sorted into clusters such as aesthetics, lighting convenience, efficiency. These clustered customer attributes are placed on the left-hand side of the matrix (the wall of the house). An index based on attribute improvement x improvement ratio x "sales point" (an estimate of how the market will respond to the improvement) is eventually developed and placed on the right hand side of the matrix The top of the matrix (or ceiling of the house) consists of column headings for technical attributes, e.g., viscosity, melting point, candle diameter. The roof of the house is formed by estimating links between these technical attributes. The cells of the matrix are filled with estimates of the link between customer and technical attributes. The basement of the house is formed by summing all the cell entries in each column. The indices developed in the basement reflect the "voice of the company."

The size of the matrix and the development of scores and relationships between scores seems formidable. However, the matrix can be simplified by using Pareto's rule that an 80% improvement in value to the customer can be achieved by dealing with only 20% of customer needs.

QFD should always be carried out in interdisciplinary teams. The team should have the support of top management and key function managers. The team should know who will make the final decision on implementing the team's recommendations. The QFD champion can be a senior manager or at least someone who gets things done.

A good place to start a QFD effort is in the quality department, a value engineering department or an industrial engineering department. It is good to start with a simple product to assure an early success. If the product is under development, hopefully its design is not frozen. A clear fit should be established between the company's business plan and vision, and the customers whose voice is to be heard through QFD. For example, what market is to be improved by increased customer responsiveness to the product?

It takes approximately 20 to 80 hours to complete a House of Quality matrix. The first meeting should last for a full eight hours. Depending on the intervals between meetings, the ultimate decision-maker should be updated on progress about every two weeks.